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MICROMYCETES AND BIOLOGICAL ACTIVITY OF SOIL IN A FOREST ECOSYSTEM IN THE MALÉ KARPATY MOUNTAINS

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Two brown forests soils, namely I/7 under the community *Dentario-Fagetum* and I/8 under the community *Carici pilosae-Carpinetum* in the transect of the Malé Karpaty mountains forest ecosystem were investigated from the microbiological point of view. A total of 11 genera of micromycetes were isolated, 7 in the I/7 area and 10 in the I/8 area. Many of the isolated micromycetes possess cellulolytic properties, e. g. *Mortierella, Trichoderma, Aspergillus, Alternaria* and *Cladosporium*. Some differences were found in the basic biological soil activities. The soil sample from the I/8 area showed, in general, higher values. The potential biological activity of both areas examined had an increasing tendency.

With its ecological conditions, the soil is a natural environment of micromycetes which represent an aerobic group of soil microorganisms. Micromycetes have an important function — they participate in the creation of humus, they disintegrate lignin and cellulose which is an essential component of cell walls and supporting tissues of plants. The mineralization of cellulose is of significance especially in carbon circulation. The estimation of biological activity is an adequate indicator of soil property, because CO_2 production and its process respond very sensitively to changes of the plant stand and to changes produced by adding organic substances. In forest soils it is of importance to know the settlement density, the structure and activity of the microflora. These soils are not manured and cultivated and nutrient circulation in them is closely tied up with the activity of those organisms which are capable of releasing nutrients from forest litter and producing humus — the fertilizing component of any soil.

Material and methods

Microbiological examination was made on two areas of the Ist transect in the Malé Karpaty Mountains. The transects and individual sampling areas have been marked out within the MAB project. The first area (I/7) represents the community *Dentario bulbiferae-Fagetum* (Zlatník 1935) Hartman 1953 and the second area (I/8)

the community *Carici pilosae-Carpinetum* R. et Z. Neuhl. 1964 (Kubíček et al., 1980). *Dentario-Fagetum* represents a Little Carpathian herbless beech forest on a slightly rolling slope of SW aspect and at an altitude of 515 m above sea level. *Fagus silvatica* is monodominant. Shrubs are completely missing. The undergrowth is sporadic and not exceeding 15 %. The soil surface is covered by vegetation 5 %, organic litter 100 %. Soil subtype — typical brown forest soil. *Carici pilosae-Carpinetum* is an oak-hornbeam stand on a slightly inclined slope of S aspect, at an altitude of 430 m above sea level. The shrub layer is negligible. The soil surface is covered by vegetation 30 %, by organic litter 100 %. The soil subtype — typical brown forest soil, very stony.

Soil samples were taken twice a month from June till September 1978 (the results indicating mean values), in October and November only once. The soil sample was taken from the A horizon from a depth of 0—5 cm. Always a fresh soil sample was processed. Instantaneous humidity was estimated by direct soil sampling into aluminium driers (Obr. 1964). For the basic physico-chemical measurements (pH, % C, and % N) and for laboratory experiments, the soil was prepared into fine earth.

The total amount of micromycetes, their generic presence and the biological activity of the soil were determined. The total amount of micromycetes was ascertained by a diluting method in agar environment according to Czapek-Dox and on fresh mash agar (Nemec, 1954). For inoculation use was made of 1 ml suspension from the dilution 1:10 000 and after 14 days of cultivation in the thermostat at a temperature of 27 °C the micromycetes were evaluated. From pure cultures obtained after inoculation on oblique fresh mash agar, the preparations were made ready for identification. Glass cultures were made or preparations directly in a drop of distilled water. Identification at the level of genera was made according to the literature: Domsch, Gams (1972), Gilman (1957), Hampl, Šilhánková (1957), Fassatiová (1979).

Biological soil activity was estimated under laboratory conditions by titration (Bernát, Seifert, 1955), both in a pure soil sample (basal activity) and in a soil sample to which 1 % glucose was added as an easily decomposable carbonaceous substrate (potential biological activity). In five repetitions each soil sample was incubated 7 days at a temperature of 25 °C and humidity adjusted once a day, if necessary, to the value of the instantaneous moisture in the field.

Results and discussion

The obtained data on the physico-chemical properties of soils are on tab. 1. It may be seen from them that both soils exhibit an acid reaction of environment, measured in both H_2O and KCl. Soil sample I/8 contained a bit higher percentage of carbon (3.975), and nitrogen (0.336). The C/N ratio was worse, however (11.8). There are no great differences between the examined soils and they may be said to have sufficient biogenic elements and humus. This is intrinsically in agreement with Šály's statement (1962) that brown forest soils, which are most widespread in our country, are healthy biologically active soils with good physical conditions, with an acid to neutral environmental reaction and with sufficient nutrients for forest stands.

The total amount of micromycetes was identified by a diluting method, applying two types of agar nutrient soils. According to the achieved results (tab. 2) the differences in the examined soils are visible. The soil sample I/8 contained, in general, a higher amount of micromycetes. The highest values were found in June, namely in both examined soils and on both nutrient

Table 1

General characteristic of the examined soils on area I/7 (Dentario bulbifera-Fagetum) and I/8 (Carici pilosae-Carpinetum)

Estimations of	I/7	I/8
pH_{H2O}	5.5	5.7
pH_{KCl}	4.9	4.9
% C	3.720	3.975
% N	0.308	0.336
C/N	12.1	11.8
% of humus	6.41	6.85

% C and % N were estimated at the Pedological Laboratory of the Department of Geobotany, Pedology and Microbiology of the Comenius Univerisity School of Natural Sciences in Bratislava.

environments (I/7 S: $14.5.10^3 . g^{-1}$, Cz-D: $6.5.10^3 . g^{-1}$ and I/8 S: $20.8.10^3 . g^{-1}$, Cz — D: $13.7.10^3 . g^{-1}$). The lowest values were found on area I/7 in November S:$6.2.10^3 . g^{-1}$ and in October Cz-D: $2.3.10^3 . g^{-1}$, and on area I/8 in October S: $5.9.10^3 . g^{-1}$ and Cz-D: $5.2.10^3 . g^{-1}$. The mentioned differences in the numbers of micromycetes, though not large, are nevertheless assumed to be affected considerably by the content of organic substances, by thermal and moisture conditions and, not in a small degree, also by the stand. These differences also influenced the generic presence of micromycetes (tab. 3). 7 genera were isolated from soil sample I/7 and 10 genera from soil sample I/8. The genera *Aspergillus* and *Penicillium* belong to the most current micromycetes. They are very frequent isolates both from uncultivated soils (Šimonovičová, 1980) and forest soils (Bernát, 1973; Sizova, 1977). Many of the isolated micromycetes belong to cellulolytic species, for example *Mortierella, Tricho-*

Table 2

Instantaneous humidity in % and total number of micromycetes in $10^3 . g^{-1}$ of dry soil in two soil samples from area I/7 (Dentario bulbiferae-Fagetum) and from area I/8 (Carici pilosae-Carpinetum) in 1978

Soil samples	I/7			I/8		
month of sampling	fresh mash agar	Czapek-Dox agar	instantaneous humidity	fresh mash agar	Czapek-Dox agar	instantaneous humidity
6	14.50	6.50	29.20	20.80	13.70	41.00
7	6.60	5.70	22.50	6.10	7.60	37.80
8	6.90	4.60	21.00	10.60	11.30	19.10
9	6.30	4.30	17.80	12.40	12.00	22.50
10	6.70	2.30	17.70	5.90	5.20	26.20
11	6.20	4.40	25.70	11.80	8.70	28.80

Table 3

Survey of the generic presence of micromycetes in two examined soil samples from area I/7 Dentario bulbiferae-Fagetum and from area I/8 Carici pilosae-Carpinetum

Genera of micromycetes	Examined soil sample	
	I/7	I/8
Absidia v Tieghem	+	+
Thamnidium Link	—	+
Mortierella Coemans	—	+
Trichoderma (Persoon) Harz	+	+
Aspergillus (Micheli) Corda	—	+
Penicillium Link	+	+
Verticillium Nees	+	+
Alternaria Nees	+	+
Trichothecium Link	+	—
Cladosporium Link ex Fr.	+	+
Pseudoeurotium v. Beyma	—	+

derma, Aspergillus, Penicillium (Mirchink, 1976), *Alternaria* (Kislitsina, 1972), *Cladosporium* (Chastukhin, Nikolaevskaya 1969). Cellulolytic micromycetes are an important part of the cellulolytic microflora, indispensible for the circulation of biogenetic elements, mainly of carbon.

For microbiological analyses soil samples are most often taken from the depth of 0—5 cm, where microorganisms and organic substances accumulate most abundantly, thus microbial activity is higher here than in the deeper layers. Maximum biological activity is also ascribed to this part of the soil. From the results of the biological activity of soil (tab. 4) it may be laid down that this process passed off differently in the examined soil samples. The values of basal biological activity were mostly lower in sample I/7 than in sample I/8. The highest basal biological activity value was found in sample I/7 in September (1178.10 mg CO_2 . 100 g^{-1} soil . 14 $days^{-1}$), the lowest in June (476.11 mg CO_2 . 100 g^{-1} soil . 14 $days^{-1}$). In sample I/8 the highest basal biological activity was registered in November (1217.11 mg CO_2 . 100 g^{-1}

Table 4

The amount of CO_2 indicated in mg CO_2 . 100 g^{-1} soil. 14 $days^{-1}$ in two soil samples from areas I/7 (Dentario bulbiferae-Fagetum) and from area I/8 (Carici pilosae-Carpinetum) in 1987

Soil samples	I/7		I/8	
month of sampling	biological activity		biological activity	
	basal	potential	basal	potential
6	476.11	856.49	503.06	993.3
7	856.24	1052.12	1023.06	1287.95
8	1097.51	1332.87	1003.05	1371.11
9	1178.10	1532.14	1187.21	1533.96
10	1118.04	1545.13	1100.07	1820.28
11	1014.35	1522.55	1217.11	2283.31

soil . 14 days^{-1}]. More pronounced differences between samples I/7 and I/8 may be observed in potential biological activity values. The addition of glucose produced in both cases a rise in the biological activity of the microflora, but the values in sample I/8 exceeded also in this case (except of the months of August and October) those of sample I/7. The values of the potential biological activity have a rising trend in both cases, with lowest values in July

Table 5

Values of the respiration quotient G/B in soil samples from two areas I/7 (Dentario bulbiferae-Fagetum) and I/8 (Carici pilosae-Carpinetum) in 1978

Month of sampling	Respiration quotient G/B	
	I/7	I/8
6	1.1	1.3
7	1.3	1.3
8	1.2	1.4
9	1.3	1.3
10	1.4	1.7
11	1.5	1.9

(I/7 856.49 mg CO_2 . 100 g^{-1} soil. 14 days^{-1} and I/8 993.3 mg CO_2 . 100 g^{-1} soil. 14 days^{-1}] and the highest ones in October (1545.13 mg CO_2 . 100 g^{-1} soil . 14 days^{-1}) in sample I/7 and in November (2283.31 mg CO_2 . 100 g^{-1} soil . 14 days^{-1}) in sample I/8.

At present, biological soil activity is examined mostly in the field with the help of various devices. Authors also indicate it in various values, such as for example in mg CO_2 . kg^{-1} soil . 14 days^{-1} (Školek, 1977), in mg CO_2 . m^{-2} soil . h^{-1} (Redmann, 1978), in mg CO_2 . 100 g^{-1} of absolutly dry soil (Pantos-Derimova, 1980). The seasonal dynamics of CO_2 production correlates with the seasonal dynamics of soil microorganisms and increases mainly toward the end of the growing season (September—November), when larger amounts of decayed residues of plant and organisms get into the soil, thus rising the activity of micromycetes.

In tab. 5 the values of the respiration quotient (G/B) are presented. This expresses the readiness of the microflora to process added organic substances. The difference is small, this means that in both samples the soil microflora is equally prepared to process the added organic substances.

The achieved results convey a partial picture of the properties of the examined soils from the microbiological viewpoint and they may serve as a basis for further examinations of this type of forest soils.

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PÔDNE MIKROMYCÉTY A BIOLOGICKÁ AKTIVITA PÔDY V LESNÝCH EKOSYSTÉMOCH MALÝCH KARPÁT

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Z mikrobiologického hľadiska sa sledovali dve hnedé lesné pôdy I/7 pod spoločenstvom *Dentario-Fagetum* a I/8 pod spoločenstvom *Carici pilosae-Carpinetum,* obidve v lesnom ekosystéme Malých Karpát. V obidvoch pôdnych vzorkách sa zistil aktívnejší rast mikromycét na sladinovom agare ako na agare podľa Czapeka a Doxa a väčšie množstvo mikromycét vo vzorke z plochy I/8 ako vo vzorke z plochy I/7. Aj rodové zastúpenie mikromycét bolo vo vzorke z plochy I/8 vyššie (11 rodov) ako vo vzorke z plochy I/7 (8 rodov). Priebeh biologickej aktivity bol rôzny s vyššími hodnotami nameranými v pôdnej vzorke z plochy I/8.

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ПОЧВЕННЫЕ МИКРОМИЦЕТЫ И БИОЛОГИЧЕСКАЯ АКТИВНОСТЬ ПОЧВЫ В ЛЕСНЫХ ЭКОСИСТЕМАХ МАЛЫХ КАРПАТ

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В лесных экосистемах Малых Карпат с точки зрения микробиологии исследовали две бурые лесные почвы: 1/7 под сообществом *Dentario Fagetum* и 1/8 *Carici pilosae-Carpinetum*. В обеих пробах обнаружен более активный рост микромицетов на сусло агаре по сравнению с агаром, а также увеличение количества микромицетов из почвы 1/8 по сравнению с 1/7. Принадлежность микромицетов по родам в пробах из площади 1/8 больше (11 родов) чем у 1/7 (8 родов). Биологическая активность протекала по-разному, более высокие величины найдены в пробе почвы 1/8.